

REMARKS

Claims 2-4, 8, 11, 42, and 44 have been amended. Claim 5 has been canceled. Claims 2-4, 8, 11-12, 42, and 44 are now pending. Applicants reserve the right to pursue the original claims and other claims in this and other applications. Please reconsider the above-referenced application in light of the foregoing amendments and following remarks.

Claims 2-5, 8, 11, and 12 stand rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. The rejection is respectfully traversed.

The Office Action asserts that “*nowhere* in the specification is it stated that the pressure is ‘held at about atmospheric pressure.’” (pg. 2) (emphasis added). This is not true. Applicants respectfully direct the Examiner’s attention to pg. 9, lines 2-5 of the specification. Applicants’ specification provides in pertinent part that, “[i]n general, the [reaction chamber’s] pressure *can* be at about atmospheric pressure.” (pg. 9, lines 2-5) (emphasis added). Accordingly, contrary to the Office Action’s assertion, claim language that “the pressure of said rapid thermal process chamber is held at about atmospheric pressure,” as recited in claim 8, *is* supported by the specification.

The Office Action further asserts that “this limitation is not enabled because the specification fails to indicate how the wet oxidation would be carried out using *in situ* reaction of hydrogen and oxygen at a pressure of about 1 atmosphere.” (pg. 2). Applicants respectfully submit, however, the Office Action has read a limitation into claim 8 that is not present. Claim 8 does *not* recite that the reaction of hydrogen and oxygen gases are carried out *in situ* in a reaction chamber. Nonetheless, to expedite prosecution, claim 8 has been amended to clarify that steam is *carried* to the rapid thermal process chamber.

Claims 2-4 and 11-12 depend from independent claim 8. For at least the reasons provided above, claims 2-4, 8, and 11-12 are supported and enabled by the specification. Applicants respectfully request that the § 112, first paragraph, rejection be withdrawn.

Claims 2-4, 8, 11-12, 42, and 44 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. patent no. 5,374,578 ("Patel") in view of U.S. patent no. 6,066,581 ("Chivukula"), and further in view of Van Zant, Microchip Fabrication: A Practical Guide to Semiconductor Processing, 3rd Ed. (pp. 157-160) (1997) ("Van Zant"). The rejection is respectfully traversed.

To establish a *prima facie* case of obviousness, three requirements must be met: (1) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine reference teachings; (2) a reasonable expectation of success; and (3) the prior art reference (or references when combined) must teach or suggest all the claim limitations. All three elements must be present for a *prima facie* case of obviousness. More importantly, the teaching or suggestion to make the claimed combination and the reasonable expectation for success *must both* be found in the prior art and not based on the Applicants' disclosure. See e.g., *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. 580 (CCPA 1974).

In this case, Patel does not disclose all of the claim limitations. Patel does not disclose or suggest "a wet oxidation with steam process," as recited in claims 8, 42, and 44. This fact is underscored by the Office Action's acknowledgement that Patel "does not teach wet oxidation during the ozone anneal." (pg. 5). The Office Action relies upon Chivukula for rectifying Patel's deficiency.

The Office Action asserts that Patel discloses depositing an oxygen deficient dielectric ferroelectric film 14; subjecting film 14 to a densifying treatment; subjecting film 14 to an annealing in ozone using RTA at a temperature of 650°C – 850°C, for about 5-30 seconds, with any pressure; and performing a stabilizing treatment. (pg. 5.). Since Patel does not disclose a wet oxidation with steam process, the Office Action turns to Chivukula.

The Office Action asserts that Chivukula discloses subjecting a dielectric film to a wet oxidation using a mixture comprising water and ozone at a temperature of 450-800°C in a RTA chamber for 30 seconds to several minutes. The Office Action further asserts that it would have been obvious to incorporate water into Patel to reduce ferroelectric stress and provide superior characteristics. Applicants respectfully disagree. There is no suggestion or motivation to combine Patel and Chivukula for at least the following reasons.

Patel relates to a method of “forming a ferroelectric capacitor using *ozone* anneals.” (col. 2, lines 7-9). Patel discloses that “[o]zone anneals provide a more complete method of supplying oxygen to the ferroelectric material than oxygen anneals since zone quickly decays to O₂ and O⁻ at temperatures above 400°C.” (col. 2, lines 11-14). As a result of the quick decay, “not only is O₂ provided to the ferroelectric material, but *also* the highly reactive O⁻ species which has a higher electron affinity than O₂ [which] is provided.” (col. 2, lines 15-18) (emphasis added). Patel also discloses a conventional organic precursor solution in which all the metals of the PZT film are provided by metallo-organic precursor compounds (col. 3, lines 42-62).

The use of ozone over oxygen, in Patel, allows quicker adsorption of an oxygen atom in a ferroelectric material such as PZT. A high concentration of oxygen atoms are provided by ozone’s quick disassociation. The liberated oxygen atoms

penetrate quickly into the PZT material; thus, reducing the anneal process time and number of Pb atoms lost.

Chivukula relates to the removal of carbon from PZT films (col. 7, lines 20-25). The removal of carbon is a critical step. Components that add an excess of carbon to a ferroelectric film, can adversely affect oxygen stoichiometry (col. 7, lines 29-31). To this end, Chivukula discloses a specific sol-gel precursor solution. Chivukula's sol-gel precursor solution has a reduced number of organic components compared to other conventional sol-gel solutions, such as disclosed in Patel, in which all metals are provided by metallo-organic precursor compounds.

There is no suggestion or motivation to combine the two references. Patel's RTA method is *shorter*, in duration (5-30 seconds), than Chivukula's disclosed RTA method. Increasing throughput is always a concern in semiconductor processes. Chivukula's method takes at least 30 seconds up to several minutes. One skilled in the art would not look to the methods of another reference in which the disclosed methods *increase* the duration of a rapid thermal process anneal, when the primary reference seeks to *shorten* the rapid thermal process anneal.

In semiconductor processing, reducing the RTA duration is a driving concern. Notwithstanding that the two references are directed to solving different problems and have different processes that, at least time wise, go in opposite directions. For example, Patel employs ozone to shorten the RTA duration and decrease the number of Pb atoms lost during an annealing process, while Chivukula employs a novel sol-gel precursor solution to reduce the number of organo-metallic compounds that contribute excess carbon. One skilled in the art would not be motivated to combine references directed to solving completely different problems.

Further, there is no reasonable expectation of success with the proposed combination. Chivukula discloses the use of a particular and *novel* sol-gel precursor solution. Patel, in contrast, discloses a *conventional* sol-gel precursor. There is no reasonable expectation that Chivukula's methods, which employ a *novel* sol-gel precursor solution, can work with a conventional sol-gel precursor process, such as Patel discloses. Applicants respectfully submit that the proposed combination of Patel and Chivukula, is improper hindsight reconstruction. The teaching or suggestion to make the claimed combination and the reasonable expectation for success *is not* found in the prior art; but, is based on Applicants' disclosure.

The Office Action further concedes that, even in combination, Patel and Chivukula still fail to disclose or suggest that steam is provided by a reaction of hydrogen with oxygen in a ratio of 0.1 to 0.5. To rectify this deficiency, the Office Action relies upon Van Zant for disclosing Dryox. The Office Action claims that Van Zant discloses Dryox, which is a mixture of hydrogen and oxygen gases reacting to form steam.

Van Zant discloses that in Dryox, "gaseous oxygen and hydrogen are introduced directly into the *oxidation tube*. Inside the tube, the two gases mix and, under the influence of the high temperature, form steam. The result is a wet oxidation in steam." (pg. 160) (emphasis added). Van Zant does not teach or suggest that the hydrogen and oxygen gas are combined *in* a rapid thermal process chamber. Van Zant merely discloses *combining the two gases in an oxidation tube*, which is different from Applicants' claimed method of "heating a mixture of hydrogen and oxygen gases . . . to form steam within [a] rapid thermal process chamber," as recited in claim 42, and "heating and combining a mixture of hydrogen and oxygen gases in a rapid thermal process chamber," as recited in claim 44.

The Office Action further asserts that Van Zant discloses that Dryox is preferred to bubblers, which is what Chivukula discloses, and that provides motivation to combine the two references. Applicants respectfully disagree. "The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." M.P.E.P. § 2143.01. In this case, Chivukula does not disclose merely a conventional bubbler as the Office Action asserts.

Chivukula discloses that water vapour is introduced into the RTA system "during the annealing of the PZT by passing oxygen (O₂) through a *double bubbler* containing purified deionized (DI) water, so that the oxygen was saturated with water vapour." (col. 13, lines 40-45) (emphasis added). Chivukula does not merely disclose a liquid bubbler; but, a specific "double bubbler" containing purified DI. Since Chivukula discloses a specific double bubbler system, there is no motivation to use a Dryox system.

Moreover, it is not proper to combine references where doing so "would require a substantial reconstruction and redesign of the elements shown in the primary reference [i.e., Chivukula] as well as a change in the basic principle under which the primary reference [i.e., Chivukula] construction was designed to operate." *In re Ratti*, 270 F.2d 810, 813, 123 U.S.P.Q. 349, 352 (C.C.P.A. 1959). This is well-settled Office policy. In this case, Chivukula discloses that water vapour is introduced, *while* the PZT film is being annealed, by passing oxygen (O₂) through a *double bubbler* containing purified DI water. Chivukula's methods and processes would require the incorporation of an oxidation tube. As indicated above, Applicants recite, in claims 42 and 44, that steam is formed *inside* the rapid thermal process chamber.

The Office Action further asserts that since "Chivukula teaches that oxygen must be in excess of the water vapor, one of ordinary skill would know, based upon the stoichiometry of the reaction between hydrogen and oxygen . . . that the ratio of hydrogen to oxygen must necessarily be less than or equal to about 0.67 because hydrogen reacts with oxygen in a 2 to 1 stoichiometric ratio." (pg. 7). The Office Action asserts that its statements must hold true "[o]therwise the oxygen will be depleted in the formation of water and excess hydrogen would remain, contrary to the teaching in Chivukula." (pg. 7).

First, Applicants respectfully submit that the Office Action has not set forth any proof that Chivukula discloses that oxygen must be in excess of water vapor. In fact, Applicants respectfully believe that there is no such statement or suggestion in Chivukula. Second, although hydrogen reacts with oxygen in a 2 to 1 stoichiometric ratio to form water, the Office Action does not take into account the affect that ozone will have upon this stoichiometric reaction. Accordingly, the Office Action cannot make a logical leap that Chivukula discloses a ratio of steam to other gases in a range of about 0.1 to about 0.5, as recited in claim 8, or that a ratio from about 0.1 to about 0.80 of hydrogen to oxygen gas exists when the gases are combined in a rapid thermal process chamber, as recited in claim 44. Finally, since ozone is present, the formation of water would not necessarily deplete oxygen lending to the situation of excess hydrogen. Applicants respectfully submit that the Office Action, is arriving at the claimed invention only in light of Applicants' disclosure.

As such, even if the references are properly combinable, which they are not, they still would not disclose or suggest the subject matter of independent claims 8, 42, and 44. The cited references would not disclose or suggest a method of fabricating a semiconductor device comprising, *inter alia*, "depositing an oxygen-deficient dielectric film . . . subjecting the dielectric film to a densifying treatment . . . subjecting said

stabilized dielectric film to a wet oxidation with steam process, said steam being carried to a rapid thermal process chamber, wherein said rapid thermal process chamber is kept at a temperature of at least about 450°C, wherein the ratio of steam to other gases . . . is in the range of about 0.1 to about 0.5, and wherein the pressure . . . is held at about atmospheric pressure; and subjecting the dielectric film to a second heat treatment," as recited in claim 8.

The cited references would not disclose or suggest a method of fabricating a semiconductor device comprising, *inter alia*, "depositing an oxygen-deficient dielectric . . . subjecting the dielectric film to a densifying treatment . . . and subjecting the stabilized dielectric film to a wet oxidation with steam process provided by heating a mixture of hydrogen and oxygen gases in a rapid thermal process chamber at a temperature of at least about 450°C to form steam within said rapid thermal process chamber," as recited in claim 42.

Similarly, the cited references would not disclose or suggest a method of fabricating a semiconductor device comprising, *inter alia*, "depositing an oxygen-deficient dielectric film . . . subjecting the dielectric film to a densifying treatment . . . subjecting the stabilized dielectric film to a wet oxidation with steam process provided by heating and combining a mixture of hydrogen and oxygen gases in a rapid thermal process chamber at a temperature of at least about 450°C, wherein said mixture is provided in a ratio from about 0.1 to about 0.80 of hydrogen to oxygen gas being combined in said rapid thermal process chamber having a pressure of around 1 millitorr; and subjecting the dielectric film to a second heat treatment," as recited in claim 44.

Claims 2-4 and 11-12 depend from claim 8 and should be allowable along with claim 8, for at least the reasons provided above, and on their own merits.

Claim 42 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Chivukula in view of Van Zant. The rejection is respectfully traversed.

For similar reasons provided above, the cited references do not disclose or suggest the subject matter of claim 42. The cited references do not teach or suggest a method of fabricating a semiconductor device comprising, *inter alia*, "depositing an oxygen-deficient dielectric . . . subjecting the dielectric film to a densifying treatment . . . and subjecting the stabilized dielectric film to a wet oxidation with steam process provided by heating a mixture of hydrogen and oxygen gases in a rapid thermal process chamber at a temperature of at least about 450°C to form steam within said rapid thermal process chamber."

Van Zant discloses a Dryox method employing an oxidation tube. Chivukula discloses employing a liquid *double bubbler* with deionized water. Both references, even in combination, do not disclose or suggest "heating a mixture of hydrogen and oxygen gases . . . to form steam within [a] rapid thermal process chamber," as recited in claim 42. Chivukula and Van Zant discloses, in contrast, that steam is carried to the reaction chamber, not formed within it. Moreover, as indicated above, there is no motivation to combine the two references. Chivukula specifically discloses the use of a liquid double bubbler rather than an oxidation tube. Thus, even if one skilled in the art would contemplate combining the two references, Chivukula would undergo a major redesign and reconstruction to accommodate an oxidation tube rather than a liquid double bubbler.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

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Respectfully submitted,

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